

DORASHAMIAN BIOSTRATIGRAPHY OF THE DOI PHA PHLUNG AREA, NORTH THAILAND

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The Dorashamian faunas of the Huai Thak Formation in North Thailand is composed by many taxa such as ammonoids, nautiloids, bivalves, gastropods, trilobites, brachiopods, rugose corals, bryozoans, foraminifers including fusulines, sponges, algac, etc., of which fusulines and ammonoids are useful for biostratigraphy of the calcareous and elastic sediments respectively. Foraminifera faunas represent the *Gallowayinella* and *Colaniella-Reichelina* zones. The ammonoids, consisting of *Paratirolites nakornsrii* and *Tapashanites yaowalakae*, occur in the uppermost horizon of the Doi Pha Phlung area. A barren zone of partly dolomitised limestone occurs at the top of 557 m at the Doi Pha Phlung and overlies the *Colaniella parva* Zone. It is interpreted that the stratigraphical horizon of the barren limestone is higher than that of the latter. The elastic rocks composed of shale, sandstone and conglomerate are in a fault contact to the shale of the Lower Triassic Phra That Formation.

THE PERMIAN Huai Thak and the Triassic Phra That Formations are widely distributed in the surveyed area, north of Lampang, northern Thailand (Fig. 1). Within those strata, ammonoids and brachiopods are generally used for the biostratigraphic zonations of the non-calcareous sediments, and foraminifers and conodonts for the calcareous ones. Some Dorashamian faunas have been previously reported from this area as follows: brachiopods (Waterhouse 1983); ammonoids, nautiloids and trilobites (Ishibashi & Chonglakmani 1990; Ishibashi et al. 1994); fusulines (Ueno & Sakagami 1991); and smaller foraminifers (Sakagami & Hatta 1982).

The stratigraphic succession from non-calcareous to calcareous sediments at Doi Pha Phlung area were measured and many kinds of faunal and floral fossils collected from a number of localities in the surveyed area. The synthetic chart of biostratigraphic correlation is made on the basis of these data. These new data offer some interesting information on fusuline zones of the Upper Permian in Thailand, the latest faunal assemblages of the Dorashamian stage and the distribution of plant fossils of the Dzhulfian in Southeast Asia.

GEOLOGICAL SETTING OF DOI PHA PHLUNG AREA

The geology of this area has been discussed by Ishibashi et al. (1994). The Huai Thak and Phra

That Formations are distributed in a north north-east to south south-west direction. The Huai Thak Formation consists of clastic and calcareous sediments and yields plenty of marine fossils in its upper part and non-marine plant fossils in its lower part. The calcareous sediment is composed of limestone and calcareous shale. The main body of the Doi Pha Phlung (Pha Phlung Mountain) and some mountains around it comprises bedded limestone with calcareous shale in its lower part. Shale and sandstone are found around the Doi Pha Phlung and other peaks. The contact between the lower and upper parts of this formation is recognised at locality 1, where it is a fault contact.

The Lower Triassic Phra That Formation consists of shale and limestone and yields several species of *Claraia* and *Ophiceras*. The contact of this formation with the Permian Huai Thak Formation is a fault, recognisable at locality 8 (Ishibashi et al. 1994).

DORASHAMIAN FAUNA OF THE HUAI THAK FORMATION

Abundant marine faunas occur in the limestones of Doi Pha Phlung and shale distributed around it (Fig. 2). The fossils (Figs 3 and 4) comprise foraminifers including fusulines, bryozoans, corals, trilobites, brachiopods, bivalves, gastropods, nautiloids, ammonoids and algac, some of which have been already reported (i.e. Waterhouse 1983;

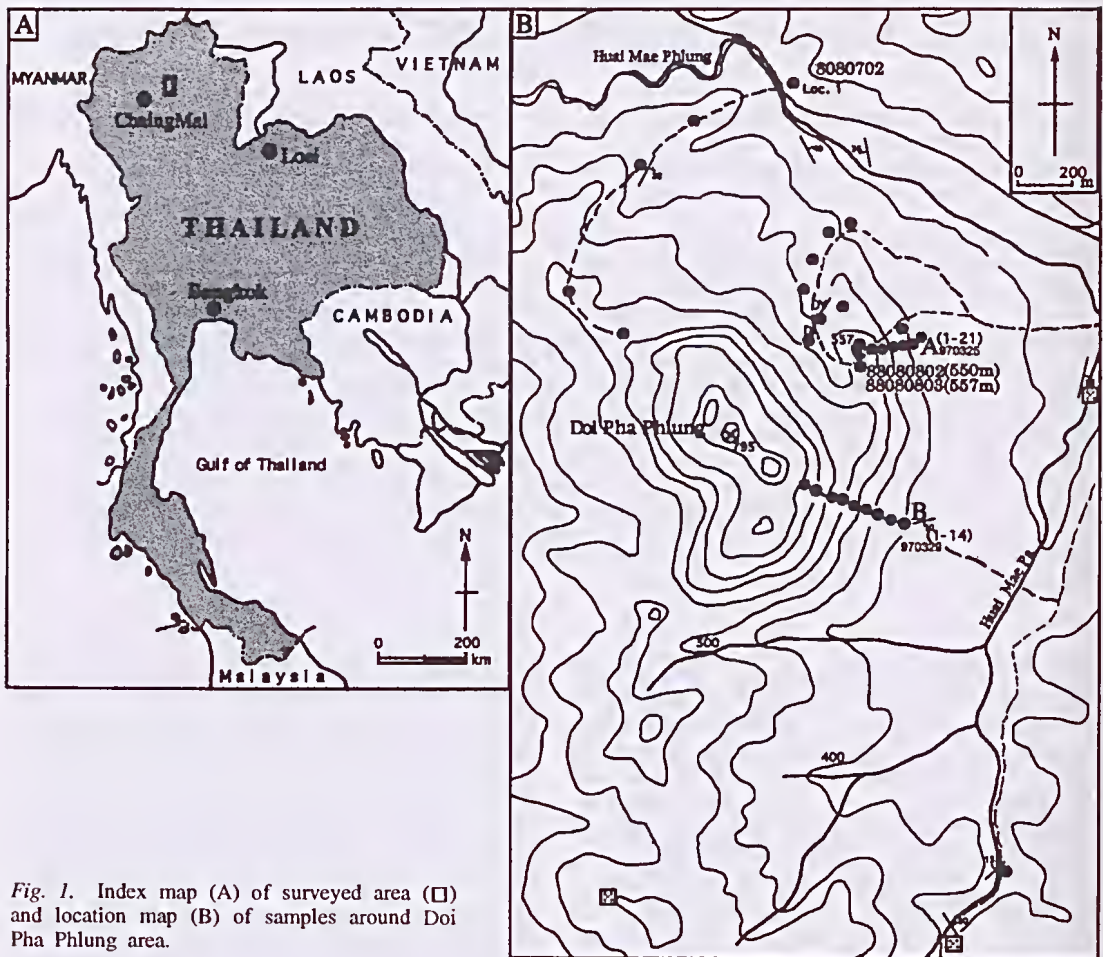


Fig. 1. Index map (A) of surveyed area (□) and location map (B) of samples around Doi Pha Phlung area.

Sakagami Hatta 1982; Ishibashi & Chonglakmani 1990; Ishibashi et al. 1994). The stratigraphical horizons of those fossils in the Huai Thak Formation are shown in Fig. 2. Fusulines and ammonoids are the most important and reliable for determination of the geologic age of Permian sediments. The former occurs in the fossiliferous limestone, while the latter is found in the shale beds. The fusulines occur in the limestone of the Doi Pha Phlung and limestone blocks in the shale beds around it. Several species of fusulines including *Gallowayinella*, *Reichelina* and *Palaeofusulina* were described from the lower part of the Doi Pha Phlung limestone (Ueno & Sakagami 1991), and the smaller foraminifers, *Paraglobivalvulina*, *Pachypulioia*, *Agathammina*, etc. were reported from the limestone of the Doi Pha Phlung (Sakagami & Hatta 1982).

Cephalopods, on the other hand, are known from the Lower Triassic (Scythian) Phra That Formation (Chonglakmani 1982; Ishibashi et al. 1994) and from the Upper Permian (Dorashamian) Huai Thak Formation (Ishibashi & Chonglakmani 1990; Ishibashi et al. 1994). It is interpreted that the Dorashamian ammonoid horizon including *Paratirolites nakornsrii*, *Tapashanites yaowalakae*, *Pseudogastriceras* aff. *szechuanense*, etc. occur at a higher stratigraphic horizon than that of the *Reichelina-Colaniella* Zone because of the occurrence of calcareous deposits (about 120 m in thickness) in the *Palaeofusulina-Reichelina* Zone at locality 12 (Ishibashi et al. 1994), the occurrence of a barren limestone (7 m in thickness) on the peak (557 m) of the Doi Pha Phlung and the occurrence of limestone blocks yielding *Palaeofusulina sinensis* and *Reichelina* cf. *changhsingensis*

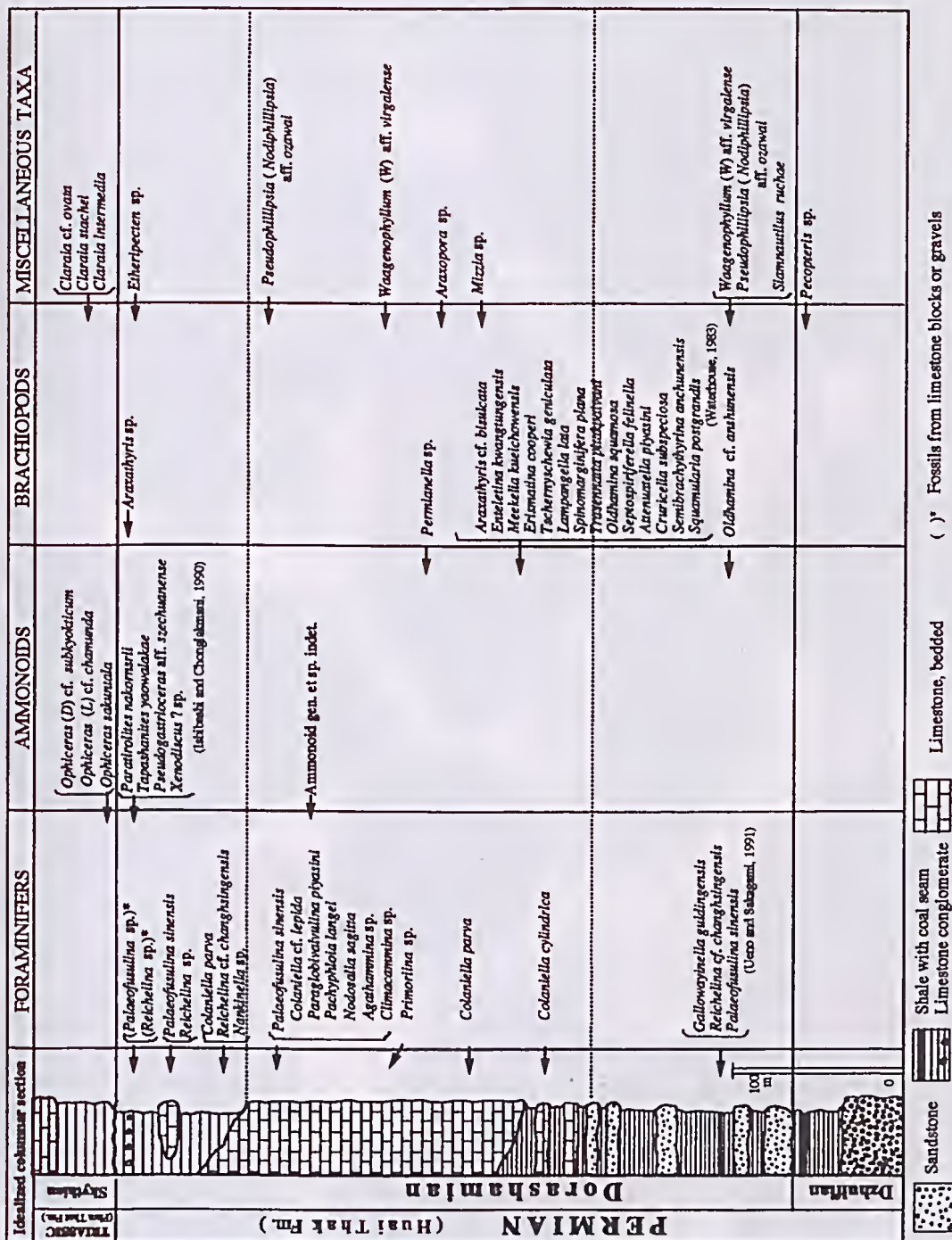


Fig. 2. Idealised columnar section of the Huai Thak Formation and associated fossils in Doi Pha Phlung area.

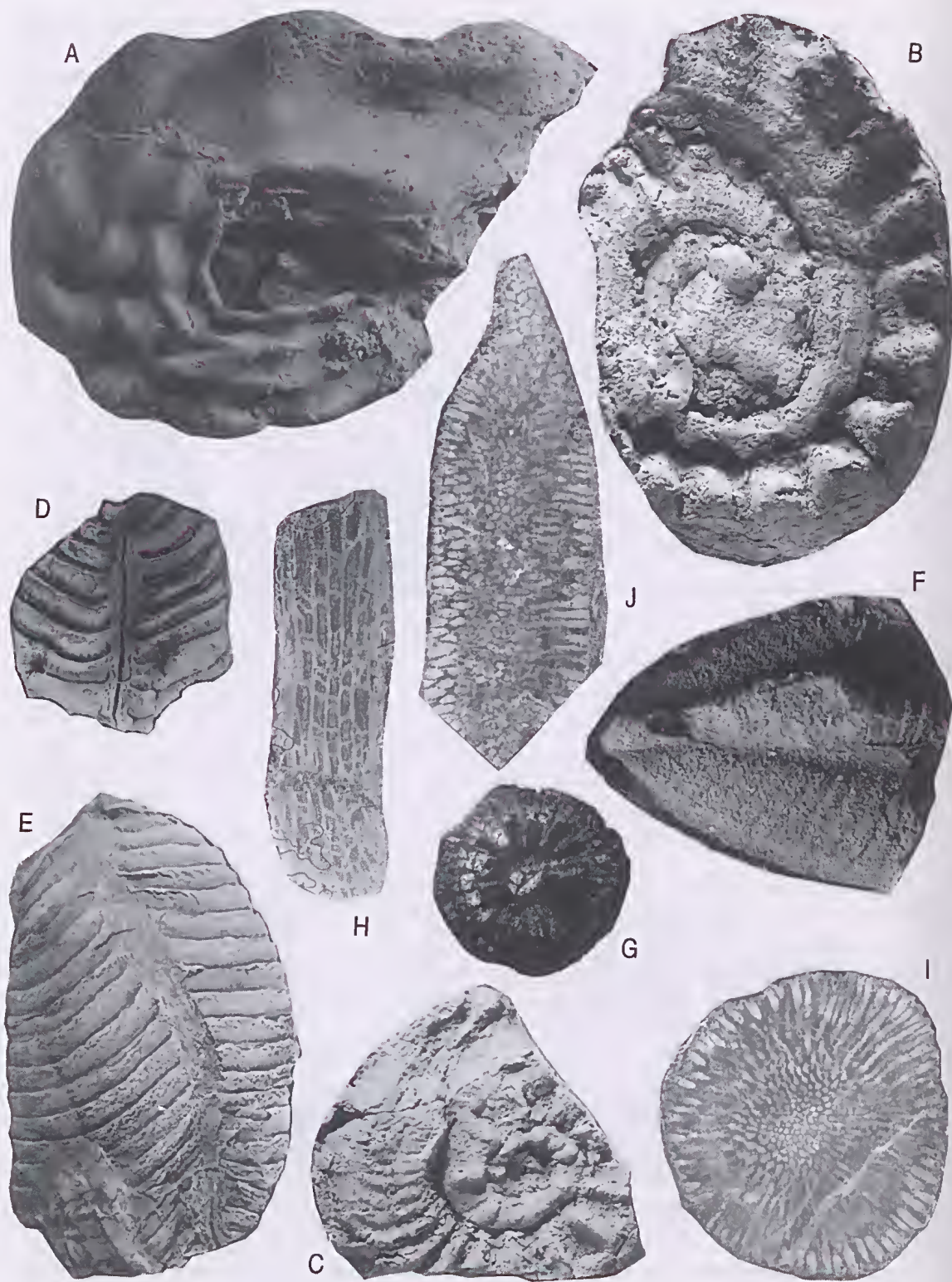


Fig. 3 (see legend on page 226)

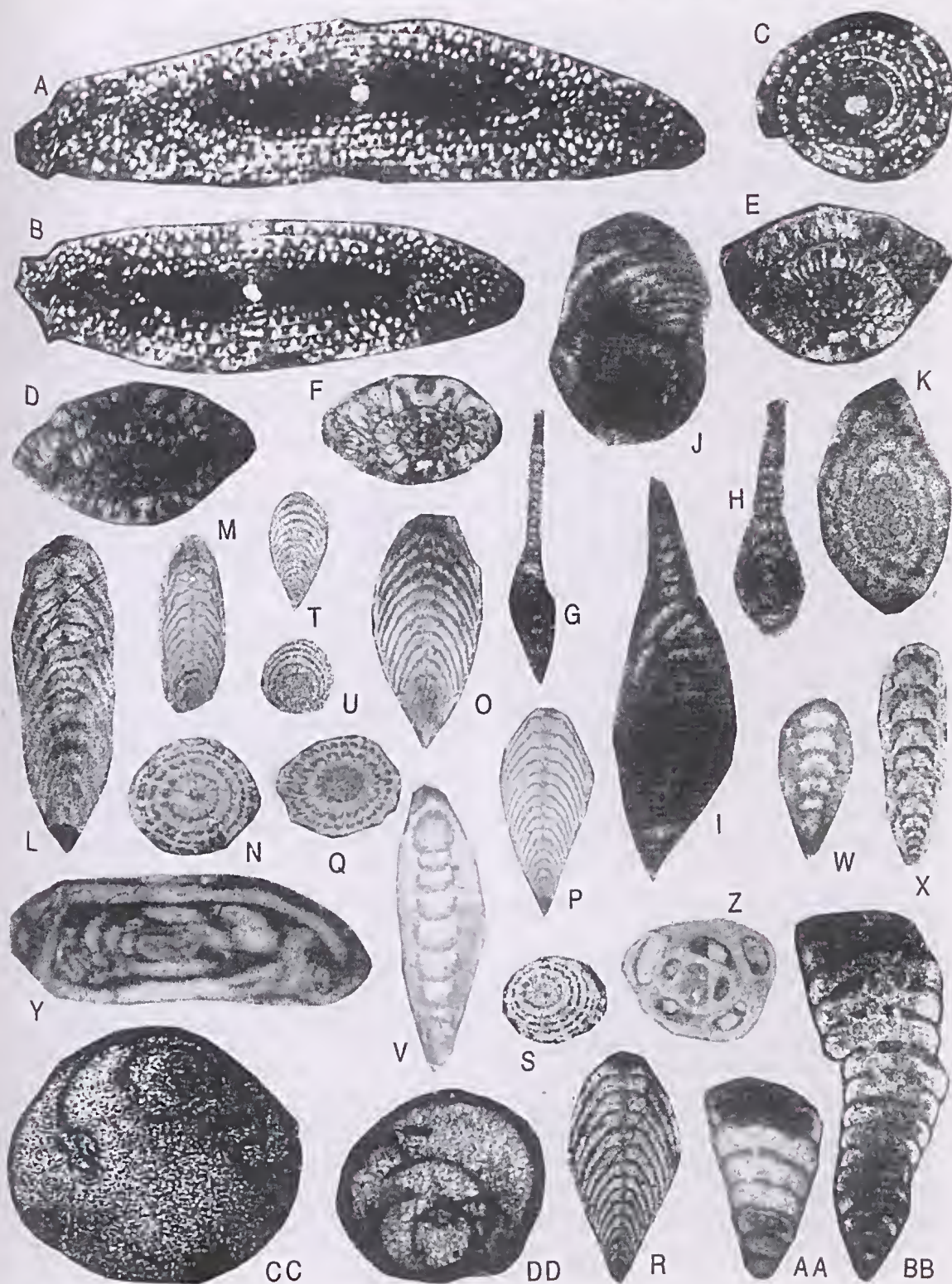


Fig. 4 (see legend on page 226)

in the shale yielding *Paratirolites nakornsrii* (Ishibashi et al. 1994).

An idealised columnar section and the stratigraphic horizons of each taxon in the Doi Pha Phlung area are shown in Fig. 2. The brachiopod fauna described from localities 11 and 12 was considered by Waterhouse (1983) to be lower Dorashamian in age, but *Palaeofusulina*-*Nankinella* Zone fusulines occur below this brachiopod fauna. It is a fact that *Palaeofusulina* is associated with *Nankinella* in this area. A lower Dorashamian fauna is recognised at locality 1, including *Gallowayinella guidingensis*, *Siamnautilus ruchae*, etc. A thin coal seam (about 20 cm in thickness) is found in the black shale at locality 1 being contacted with the overlying marine shale by a fault. Details of the coal seam is currently under study. Plant fossils, including *Pecopteris* sp., occur in the carbonaceous shale in the same section. This is considered as non-marine sediments of the upper Dzhulfian.

Stratigraphic correlation of the Upper Permian in the Tethys has been reported on the basis of fusulines, ammonoids, brachiopods, etc. (i.e. Kotljar 1989; Ishibashi et al. 1994). More detailed faunal assemblages of the Dorashamian have been elucidated by this work from the Doi Pha Phlung in northern Thailand. It is well known that one of the fusulinids, *Nankinella*, generally appears in the lower Dorashamian of the world but it is also found at a higher stratigraphic horizon associated with *Palaeofusulina* faunas in Doi Pha Phlung in north Thailand. *Gallowayinella guidingensis* is considered to be early Dorashamian age and equivalent to lower Changxingian in South China. The ammonoid fauna occurs in association with *Paratirolites nakornsrii* and *Tapashanites yaowalakae* and is in the highest stratigraphic horizon of the Permian in Thailand.

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Legends to Figs 3 and 4.

Fig. 3. Dorashamian fauna of Doi Pha Phlung—1: A, *Siamnautilus ruchae* Ishibashi, Nagai et Nakornsri, $\times 1$. B, *Paratirolites nakornsrii* Ishibashi et Chonglakmani, $\times 1$. C, *Tapashanites yaowalakae* Ishibashi, Nagai et Nakornsri, $\times 1$. D, *Oldhamina* cf. *anshunensis* Huang, $\times 2$. E, *Oldhamina squamosa* Huang, $\times 1$. F, *Pseudophillipsia* (Nodiphillipsia) aff. *ozawai* Kobayashi et Hamada, $\times 5$. G-H, *Waagenophyllum* (Waagenophyllum) aff. *virgalense* (Waagen et Wentzel), transverse and longitudinal sections, respectively, $\times 10$. I-J, *Araxopora* sp., transverse and longitudinal sections, respectively, $\times 10$.

Fig. 4. Dorashamian fauna of Doi Pha Phlung—2: A-C, *Gallowayinella guidingensis* Liu, Xiao et Dong: A-B, axial sections; C, sagittal section, $\times 20$. D-F, *Palaeofusulina sinensis* Sheng: D-E, axial sections; F, oblique-centred section, $\times 20$. G-J, *Reichelina* cf. *changhsingensis* Shen et Chang: G-I, axial sections; J, sagittal section; $\times 20$; I-J, $\times 50$. K, *Nankinella* sp., axial section, $\times 20$. L-N, *Colaniella cylindrica* M-Maklay: L-M, axial section; N, sagittal section; L, $\times 30$; M, $\times 20$. O-S, *Colaniella parva* (Colani): O-P, R, axial sections; Q, S, longitudinal sections, $\times 20$. T-U, *Colaniella* cf. *lepidia* Wang: T, axial section; U, oblique section, $\times 20$. V-W, *Pachyphloia langei* Sosnina, axial sections; V, $\times 25$; W, $\times 20$. X, *Nodosalia sagitta* M-Maklay, axial section, $\times 20$. Y-Z, *Agathamnina* sp.: Y, axial section; Z, sagittal section, $\times 20$. AA-BB, *Climacamnina* sp., $\times 20$. CC-DD, *Paraglobivalvulina piyasini* Sakagami et Hatta, $\times 20$.